

# Microbial Colonization of Needleless Intravenous Connectors and the Male Luer End of IV Administration Sets: Does the Partner Matter?

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## ABSTRACT

**Background**  
 Use of positive-displacement, needleless intravenous connectors (NCs) has been associated with increased rates of bloodstream infection (BSI). The U.S. FDA has recently issued makers of these NCs to determine if their devices increase the risk for BSIs. Whether neutral displacement NCs or the male luer (ML) end of IV administration sets play a role in central line associated BSIs (CLABSIs) is unclear.

**Objectives**  
 To determine a) the microbial colonization rates of neutral displacement NCs and ML of IV administration set ends, and b) if cross-contamination of NCs, MLs and/or the bloodstream occurs.

**Methods**  
 NCs and MLs from patients admitted to 5 different intensive care units at Loyola University Medical Center (LUMC) were cultured using direct plating and broth enhancement in the LUMC microbiology lab. Isolates from NC:ML pairs and device:blood pairs were typed using pulsed field electrophoresis if collected sets yielded concordant growth. CLABSI was defined according to CDC/NHSN definitions.

**Results**  
 We cultured 279 devices (212 NCs, 67 MLs) from 78 patients. 50 (24%) NCs and 25 (37%) MLs cultured positive for a micro-organism. Use of NC for ≥ 7 days and hospitalization in the study units for ≥ 14 days were associated with increased microbial colonization of NCs. 38 patients had simultaneous cultures of both NCs and MLs. Of these, 11 pairs from 7 patients yielded concordant microbial growth, 21 pairs from 15 patients were discordant and 23 pairs from 16 patients had no growth. 2 NC:ML pairs (1 *P. aeruginosa*, 1 coagulase negative staphylococcus) were indistinguishable by molecular typing. 31 blood cultures from 19 patients were positive during hospitalization in study units. 8 patients had CLABSIs (1 was admitted from a long-term care facility with CLABSI), 8 patients had 9 clinically insignificant positive blood cultures and 8 had bacteremia from another source. 2 patients with CLABSI (*Enterobacter aerogenes* and *Klebsiella pneumoniae*) had central venous catheters and NCs changed upon diagnosis. NC cultures obtained more than 1 week later were positive for similar organisms. One pair (*K. pneumoniae*) was closely related (2 band difference) by molecular typing.

**Conclusion**  
 Both NCs and the ML of IV administration sets are colonized by similar organisms and serve as potential reservoirs for CLABSI or clinically insignificant positive blood cultures. Molecular data confirm that cross-contamination of NCs, MLs and the bloodstream occurs. Colonization of MLs may have greater significance due to its potential to introduce microorganisms into the flow tract, which cannot be disinfected by scrubbing the NC hub.

## INTRODUCTION

Colonization of a central venous catheter hub is a significant factor in the pathogenesis of central line associated bloodstream infection.

Use of positive displacement, luer-activated needleless intravenous connectors (NCs) are associated with increased rates of bloodstream infections<sup>1-4</sup>.

While failure to protect the male luer (MLs) of IV administration sets has been identified as a potential source of infection<sup>5</sup>, this has not been studied.



**PHOTOS.** (Left) Needleless connector (NC) and IV administration set interface in an ICU patient. (Center) Uncovered NC with dried blood on the outer surface. (Right) Disconnected primary IV administration set with uncapped male luer.

## OBJECTIVES

### Primary objectives:

- To determine the microbial colonization rates of a neutral displacement needleless intravenous connectors (NCs) (InVision Plus, RyMed) and the male luer (ML) of IV administration set ends.
- To determine if micro-organisms can be transferred between the NC and the ML.

### Secondary objective:

To determine the microbial relationship between colonized NCs or MLs and bloodstream isolates.

## METHODS

**Study site:** The study site was a 567 bed academic medical center in a western suburb of Chicago. NCs and MLs were collected from patients admitted to 5 ICUs (2 medical, 2 surgical, 1 neurological) who required use of central venous catheters. The study was conducted between October 2009 and June 30, 2010. Our hospital policy requires that NCs be changed every 4 days. Two of the 5 study units use a protocol whereby NCs are changed twice a week. The other 3 units do not use a protocol. Nurses in all ICUs routinely record NC changes in the electronic medical record and we used this to determine the duration that collected NCs were used. IV administration sets are changed every 4 days except for sets used for TPN, lipid infusion and transfusion of blood products, which are changed every 24 hours.

**Specimen collection:** NCs and MLs were collected and placed individually into sterile specimen collection cups at the time of device collection. Sterile scissors from suture removal kits were used to collect MLs. Devices were refrigerated and cultured within 12 hours of collection.

**Microbiology:** Devices were cultured in the Loyola clinical microbiology laboratory. Culture method for NCs was adapted from a previous investigation<sup>3</sup>. 3 ml of thioglycollate broth was injected into NCs using sterile syringe. An aliquot was plated onto blood agar, chocolate agar and anaerobic plates and the remainder was inoculated into thioglycollate broth. A sterile swab moistened with thioglycollate broth was used to swab the ML. The swab was used to streak blood and chocolate agar plates and placed into thioglycollate broth. Cultures were incubated for 5 days. Organisms were identified using standard microbiology techniques. Selected isolates were typed using pulsed gel field electrophoresis (PGFE) at ARUP Laboratories (Salt Lake City, UT).

**Blood culture analysis:** Two members of the study team independently reviewed the chart to determine source of bacteremia in patients with positive blood cultures. Central line associated bloodstream infection was defined according to CDC/NHSN definitions. Discrepancies were adjudicated by a 3<sup>rd</sup> study team member.

## RESULTS

**Table 1.** Results overview

Number of patients	78
<sup>a</sup> Duration of admission in study unit prior to NC collection, days	14 (9-23)
<sup>a</sup> Duration of CVC use prior to NC collection, days	8 (6-15)
<sup>a</sup> Duration of NC use prior to culture, days	5 (4-7)
<sup>b</sup> % Positive needleless connector culture	24 (50/212)
<sup>b</sup> % Positive male luer culture	37 (25/67)

<sup>a</sup> Data presented as Median (Interquartile range)  
<sup>b</sup> ML vs. NC; p=0.04 (Chi Square)

**Table 2.** Microbiology results.

	NC N=50	ML N=25	NC:ML Pairs N=11	CLABSI Isolates N=8	Clinically Insignificant Cultures N=9
Polymicrobial	7	7	3	1	0
Single organism	43	18	8	7	9
Coagulase negative staphylococcus	36	21	10	5	4
<i>Propionibacterium</i> sp.	6	0	0	0	1
<i>Pseudomonas aeruginosa</i>	4	1	1	1	0
<i>Corynebacterium</i> sp.	3	1	0	0	1
<i>Enterococcus</i> sp.	3	1	0	0	1
<i>Bacillus</i> sp.	2	5	2	0	1
<i>Candida</i> sp.	2	1	1	0	0
<i>Micrococcus</i> sp.	1	1	0	0	0
<i>Enterobacteriaceae</i>	2	0	0	3	0
<i>Streptococcus</i> sp.	1	0	0	0	1
<i>Staph. aureus</i>	0	0	0	1	0

55 NC:ML pairs were collected from 38 patients. 11 pairs (20%) from 7 patients yielded concordant results, 21 pairs (38%) yielded discordant results and 23 pairs (42%) had no growth.

**Table 4.** Risk factors for increased NC colonization

	Univariable	Multivariable
NC use ≥ 7 days	2.0 [1.1, 3.8]	1.8 [0.9, 3.5]
Duration of admission ≥ 14 days	2.1 [1.0, 4.0]	2.3 [1.1, 4.7]
Site of CVC	1.2 [0.9, 1.7]	1.4 [0.9, 2.0]
Duration of CVC ≥ 8 days	1.5 [0.8, 2.9]	-
Compliance with NC change	0.8 [0.4, 1.6]	-
Number of CVC lumens	1.5 [0.8, 2.7]	-

Logistic regression was used to model the relationship between microbial colonization of the NC and NC use for ≥ 7 days, duration of admission prior to collection of NC, duration of CVC use prior to collection of NC, compliance with NC changing policy, number of CVC lumens and the site of CVC insertion. Variables with p ≤ 0.2 were included in the multivariable model. The final model consisted of use of NC for 7 or more days, admission for ≥ 14 days and site of CVC. Data are presented as Odds Ratio [95% Confidence Interval].

**Table 3.** Data by presence or absence of twice weekly NC changing protocol.

	Protocol N=105	No Protocol N=107	P <sup>*</sup>
Compliance with NC change	64%	24%	<0.001
Duration of NC use	4 (3-6)	7 (5-8)	<0.001
Duration of admission	14 (10.0-25.0)	13.5 (7.3-22.5)	0.7
Duration of CVC use	11 (7-17)	7 (5-13)	0.06
<b>Positive NC cultures</b>	<b>21%</b> <b>(22/105)</b>	<b>26%</b> <b>(28/107)</b>	<b>0.7</b>
<b>Positive ML cultures</b>	<b>36%</b> <b>(9/25)</b>	<b>38%</b> <b>(16/42)</b>	<b>1</b>

Duration = Median (IQ Range) days before NC were collected and cultured  
<sup>\*</sup> Chi Square with Yates correction for proportions, Wilcoxon Rank Sum for continuous variables

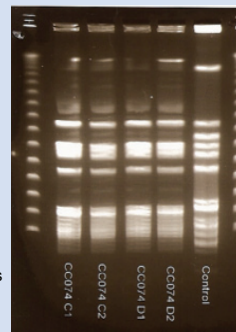
### Relationship between NC : ML and NC : blood Isolates

NC:ML pair collected from 1 patient were positive for Coagulase negative Staphylococcus – Isolates indistinguishable (Figure)

1 pair collected from another patient was positive for *P. aeruginosa* – indistinguishable (data not shown)

18 of 78 patients had 31 positive blood cultures. 8 patients had central-line associated BSI, 7 patients had 9 episodes of clinically insignificant positive blood cultures.

Two patients with CLABSI had similar organisms isolated from NC collected >1 week after CVC change and antibiotic therapy  
 -*K pneumoniae* (closely related)  
 -*Enterobacter aerogenes* (not typed)



**Figure 1.** PGFE of Coagulase negative staphylococcus isolated from needleless connector (CC074 C1 and C2) and the male luer (CC07 D1 and D2) collected from one patient.

## CONCLUSIONS

Microbial colonization of neutral displacement NC occurs at a rate similar to positive displacement NCs<sup>4</sup> and can potentially lead to CVC hub colonization.

Prolonged hospitalization in an ICU (14 or more days) is associated with increased risk of NC colonization. There is a trend to increased colonization of NCs used for 7 or more days.

Compliance with NC change was low but was higher in units where NCs were changed twice weekly. Surprisingly, improved compliance with NC change according to hospital policy was not associated with reduced NC colonization.

The ML of IV administration sets are colonized at a greater frequency than NCs and molecular data confirm that organisms can be transferred at the NC:ML interface. Colonization of the ML can potentially introduce organisms into the flow track of NCs which cannot be disinfected by scrubbing the surface of NCs.

Molecular data suggests that NCs can serve as latent reservoirs for BSI.

## LIMITATIONS

Host factors were not taken into consideration.

Compliance with IV tubing change and disinfection of NCs prior to access was not measured.

CLABSIs were defined by CDC surveillance definitions and more precise quantitative methods were not used.

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